

Quieter Pavement Test Section Summary Descriptions

Contract 7134

I-5

52nd Avenue West to SR-526 – Southbound
MP 180.10 to MP 189.30

Contract 7353

SR-520

Eastside Quieter Pavement Evaluation Project
MP 4.24 to MP 5.82

Contract 7283

I-405

112TH AVE SE to SE 8TH ST
MP 9.33 to MP 12.76



April 2011

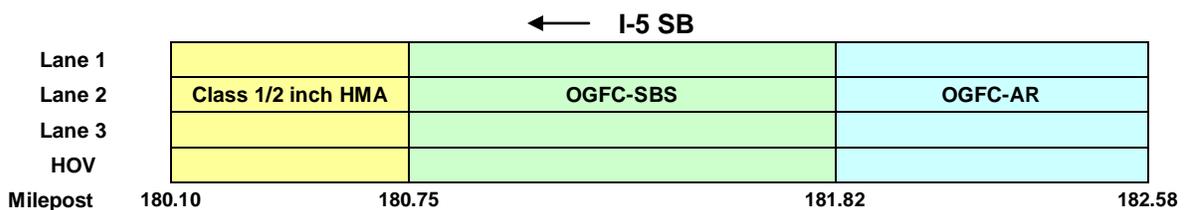
Introduction

WSDOT built three quieter pavement test sections on major urban freeways between 2006 and 2009 to determine if these types of pavements can be viable tools to reduce noise in urban locations. The following report summarizes the primary features of each project beginning with a description of the project and its location. Information is presented on the weather during the paving of the sections, the temperatures of the asphalt as delivered to the project and behind the paving machine, the application of the tack coat, the mix designs used for both types of open-graded asphalts, and a the aggregate gradations and asphalt contents. The report is intended to show the similarities and differences between the three projects.

Project Descriptions

I-5 Lynnwood, Contract 7134, 52nd Avenue West to SR-526 – Southbound

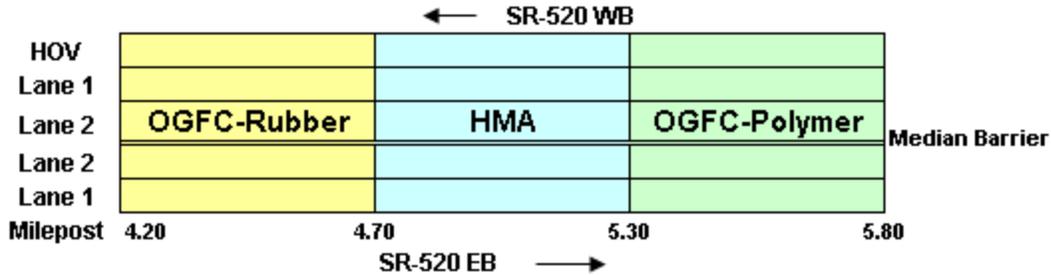
The Lynnwood quieter pavement tests sections are located on southbound I-5 between NE 44th (MP 180.10) and Interstate 405 (MP 182.58). The project included two OGFC test sections and a control section. When driving north to south the first test section is the OGFC-AR starting at the Interstate 405 undercrossing (MP 182.58) and ends just after the off ramp to SR 524 / 196th St. SW (MP 181.82). The OGFC-SBS section starts where the OGFC-AR section ends and continues to the pavement seat of the NE 44th overcrossing (MP 180.75). The test sections encompassed all four lanes. The remainder of the project (MP 180.10 to 188.75) received a 0.15 foot mill and fill with Class ½ inch HMA.



SR 520 Medina, Contract 7353, Eastside Quieter Pavement Evaluation Project

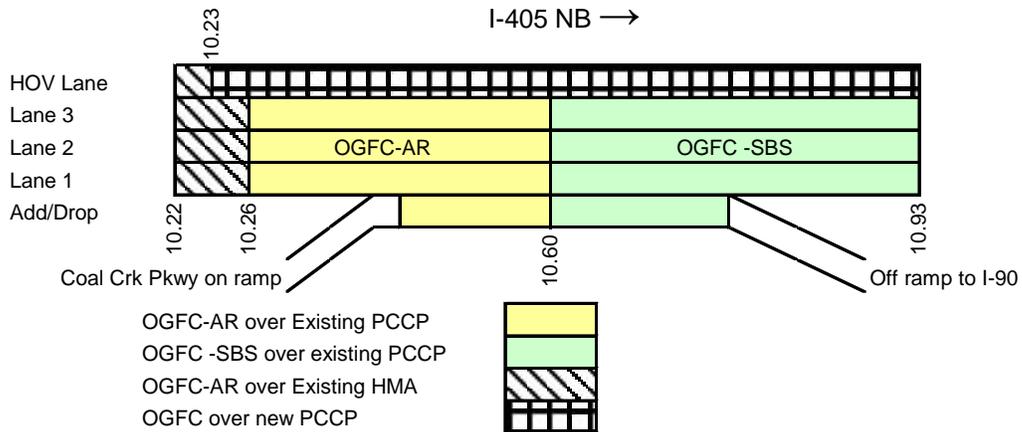
The paving limits extend from just east of the Evergreen Point Road undercrossing (MP 4.18) to just west of the Bellevue Way/104 Ave NE interchange (MP 5.82). From west to east the first section is OGFC-AR beginning just past the Evergreen Point Way undercrossing (MP 4.18) and extending to about 0.1 mile east of the 84th Ave NE

undercrossing (MP 4.68). A control section consisting of Class ½ inch HMA PG64-22 begins where the OGFC-AR ends and extends to about 0.1 mile east of the 92nd Ave NE undercrossing (MP 5.26). The OGFC-SBS test section makes up the rest of the project ending just before the Bellevue Way/104 Ave NE interchange (MP 5.82). Each section encompassed all lanes in both directions.



I-405 Bellevue, Contract 7283, 112th Ave SE to SE 8th St

The OGFC was placed in two sections on only the northbound lanes of I-405 on either side of the I-90 crossing. The southern section extends from MP 10.22 to MP 10.93. The northern section begins at MP 11.76 and extends to MP 12.40. The project added an HOV lane in each direction of I-405 between MP 9.33 to MP 12.76. The test sections encompass all four lanes, three general purpose and one HOV. The collector and add/drop lanes are not included in the study.



machine ranged from 261°F to 324°F with an average of 298°F. No temperature readings were taken on September 23rd.

SR 520 Medina

Paving on SR 520 took place during a full closure on the weekend of July 14-15, 2007. Paving of the OGFC-AR began at 7:00 a.m. Saturday morning and was completed by 2:00 p.m. that afternoon. The control section of HMA was paved during the afternoon and evening on Saturday. The OGFC-SBS paving began at 12:30 a.m. on Sunday morning and was completed by 7:00 a.m. Temperatures ranged between the upper 50's and mid 80's at the Sand Point weather station (see below). There was no precipitation recorded during the weekend.

Weather recorded at Seattle (Sand Point) weather station.		
Date	Temperatures	Precipitation
July 14	57-85	none
July 15	65-80	none

Temperatures behind the paver for the OGFC-AR ranged from 245°F to 297°F with an average temperature of 271°F. For the OGFC-SBS they were between 247°F and 300°F with an average of 282°F. Delivery temperatures were not recorded.

I-405 Bellevue

The test sections were paved during the day over the weekend of August 15th and 16th, 2009. The paving required northbound I-405 to be restricted to one lane of traffic. A weekend was chosen because the traffic disruption would be less on a weekend than a week day; however the weekend lane closures still resulted in considerable traffic delays. Paving operations began on the 15th with the two leftmost lanes of the test section south of I-90. Paving started at the Coal Creek Parkway Bridge and progressed northward toward I-90. Once the left two lanes of the test section south of I-90 were complete the equipment was moved to the test section north of I-90 to pave the left two lanes there. The process was repeated on the 16th for the right lanes.

Temperatures ranged from overnight lows in the middle 50's to daytime highs in the upper 60's to middle 70's. There was no precipitation recorded during the weekend.

Weather recorded at Seattle (Sand Point) weather station.		
Date	Temperatures	Precipitation
August 15	52-68	none
August 16	55-74	none

Temperatures behind the paver were 290 to 300°F. These temperatures were consistent with those found in Arizona when paving with the same materials. Temperatures of the mix delivered to the project were around 345°F. A Roadtec Shuttle Buggy® material transfer device was used to remix the material prior to its introduction to the paving machine. Temperatures of the asphalt transferred from the Shuttle Buggy into the paver hopper were typically around 325°F.

Tack Coat Application

I-5 Lynnwood

Tack coat coverage was sporadic at startup but became more consistent after approximately 500 feet of application. Tracking caused by the Shuttle Buggy and delivery truck tires occurred in the wheelpaths. This amount of tracking was minimal in areas of good coverage but was somewhat substantial in areas that received light coverage (startup locations).



Typical tack coat application with some pickup visible in the center of the photo.



Inconsistent tack coat coverage with the presence of small globules of tack.

SR 520 Medina

The tack coat application was sporadic with streaking in the eastbound lanes of the OGFC-AR but the application was fairly uniform on the westbound lanes. The tack applied on the OGFC-SBS was also erratic with streaking. Some tracking of the tack coat by the Shuttle Buggy and delivery trucks was observed in the wheelpaths but it was not as substantial as that which occurred on the OGFC project on I-5 near Lynnwood.



Tack coat distributor at the beginning of a pass showing streaky coverage.



Streaky tack coat application.

I-405 Bellevue

The tack coat specification on this project was different from the first two OGFC quieter pavement projects. The first two projects required tack coat consisting of emulsified asphalt but a performance grade (PG) asphalt tack coat was required on I-405. ADOT originally only allowed PG asphalt as tack coat for OGFC paving. Even though ADOT now allows the use of emulsions as tack coat, it was decided to follow ADOT's original procedure and use PG asphalt for the tack coat. The specification allowed tack coat to meet the requirements of either PG58-22 or PG64-22. Lakeside Industries chose to use PG64-22 from U.S. Oil in Tacoma, WA.

The only significant problem encountered while paving the OGFC was the PG asphalt tack coat sticking to tires on the end dumps and the Shuttle Buggies in the new PCCP HOV lane. The tack coat stuck to equipment tires to the point that bare spots were left where there was no tack coat coverage. The problem with the tack coat was attributed to dust on the surface of the new PCCP in the HOV lane which had not yet been opened to traffic. The dust prevented the tack from adhering to the pavement so it was picked up by equipment tires. The PG asphalt tack coat did perform adequately on the old PCCP and the existing HMA near the Coal Creek Parkway Bridge. It is not clear if an emulsion

based tack coat would have performed better. The lower viscosity of emulsified asphalt may have allowed it to better penetrate the dust and stick to the pavement.



Bare spots resulting from tack coat pick up by equipment.



Tack coat sticking to tires.

The PG asphalt tack coat sticking to tires led to isolated fat spots showing up in the mat due to pieces breaking away from tires. The buildup of tack occasionally required the paving crew to remove it from the tires. Most of the tack was removed from the roadway but pieces that were left on the mat in front of the paver would later show up as fat spots in the finished mat.



Glob of tack coat left on the pavement in front of the paving machine.



Fat spot in OGFC from glob of tack coat left on the pavement.

Mix Designs

I-5 Lynnwood

Special mix design processes were required for both of the open-graded pavements. The asphalt rubber mix design was the design developed and used by the Arizona Department of Transportation (ADOT). The polymer mix design was developed in-house and based on discussions from the National Center for Asphalt Technology (NCAT) and it used a slightly modified version of the ADOT aggregate gradation for open-graded friction courses.

Mix design for the I-5 Lynnwood OGFC-AR.			
Sieve Size	Gradation	Specifications	Source/Supplier
3/8"	100	100	B-335
#4	34	30-45	B-335
#8	8	4-8	B-335
#200	1.5	0-2.5	B-335
Binder Grade	Percent Asphalt		Source/Supplier
PG64-22	9.2		Tesoro, Anacortes, WA
Anti-Strip	Percent		
ARR-MAZ 6500	0.50		Arr-Maz Custom

		Chemicals, Mulberry, FL
Crumb Rubber	Percent by Wt. of AC	Source/Supplier
CRM	22	Crumb Rubber Manufacturers, Rancho Domingo, CA

Mix design for the I-5 Lynnwood OGFC-SBS.			
Sieve Size	Gradation	Specifications	Source/Supplier
3/8"	100	100	B-335
#4	37	35-55	B-335
#8	10	9-14	B-335
#200	2.1	0-2.5	B-335
Binder Grade	Percent Asphalt		Source/Supplier
PG70-22	8.3		US Oil, Tacoma, WA
Anti-Strip	Percent		Source/Supplier
ARR-MAZ 6500	0.25		Arr-Maz Custom Chemicals, Mulberry, FL
Stabilizing Additive	Percent		Source/Supplier
Processed recycled paper	0.30		Hi-Tech Asphalt Solutions

SR 520 Medina

Special mix design processes were required for both of the open-graded pavements. Both mix designs were done in-house in contrast to the Lynnwood quieter pavements project that borrowed the services of the Arizona Department of Transportation (ADOT) to develop the design for the asphalt rubber mix. The asphalt rubber mix design, however, was still patterned after the ADOT process and used the same aggregate gradation as the Lynnwood project. The SBS mix design was based on a drain down test as was used on the Lynnwood project.

Mix design for the SR 520 Median OGFC-AR.			
Sieve Size	Gradation	Specifications	Source/Supplier
3/8"	100	100	B-335
#4	31	30-45	B-335
#8	8	4-8	B-335
#200	1.6	0-2.5	B-335
Binder Grade	Percent Asphalt		Source/Supplier
PG64-22	9.0		Paramount RB, Seattle, WA
Anti-Strip	Percent		
ARR-MAZ 6500	0.25		Arr-Maz Custom Chemicals, Mulberry, FL
Crumb Rubber	Percent by Wt. of AC		Source/Supplier

CRM	23.5	Crumb Rubber Manufacturers, Rancho Domingo, CA
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Mix design for the SR 520 Medina OGFC-SBS.			
Sieve Size	Gradation	Specifications	Source/Supplier
3/8"	100	100	B-335
#4	36	35-55	B-335
#8	12	4-8	B-335
#200	2.3	0-2.5	B-335
Binder Grade	Percent Asphalt		Source/Supplier
PG70-22	8.8		US Oil, Tacoma, WA
Anti-Strip	Percent		
ARR-MAZ 6500	0.25		
Custom Chemicals, Mulberry, FL			
Stabilizing Additive	Percent		Source/Supplier
Processed recycled paper	0.30		Hi-Tech Asphalt Solutions

I-405 Bellevue

The mix design for the OGFC-AR was similar to the design for the I-5 and SR 520 projects. The asphalt percentage was slightly higher than the first two projects (9.4 percent vs. 9.2 percent for I-5 Lynnwood and 9.0 percent for SR 520 Medina). Crumb rubber was added at 20 percent of the weight of the binder which was lower than the 22 percent used on I-5 Lynnwood and the 23.5 percent used on SR 520 Medina. The aggregate gradation for both the OGFC-AR and the OGFC-SBS was similar to the first two projects but the aggregate came from Lakeside Industries' Issaquah pit (A-189) instead of pit site B-335. An important change in the OGFC-AR mix design on I-405 Bellevue was the use of lime as the anti-stripping additive. The first two projects followed WSDOT's procedure of using liquid anti-stripping additive to prevent stripping. One of the goals of the I-405 paving was to follow ADOT's procedures as close as possible. ADOT uses hydrated lime as anti-stripping additive in its OGFC mixes so the anti-stripping additive specification was changed to require hydrated lime. Hydrated lime was added at a rate of 1.0 percent of the aggregate weight.

Mix design for the I-405 Bellevue OGFC-AR.			
Sieve Size	Gradation	Specifications	Source/Supplier
3/8"	100	100	A-189
#4	35	30-45	A-189
#8	8	4-8	A-189

#200	1.9	0–2.5	A-189
Binder Grade	Percent Asphalt		Source/Supplier
PG64-22	9.4		U.S. Oil, Tacoma WA
Anti-Strip	Percent		Source/Supplier
Hydrated Lime	1% by wt of aggregate		Graymont Inc.
Crumb Rubber	Percent by Wt. of AC		Rubber Granulators Inc.
CRM	20.0		Rubber Granulators Inc.

The mix design for the OGFC-SBS was also similar to the design used for the I-5 Lynnwood and SR 520 Medina projects. The asphalt content was 0.3 percent higher than I-5 and 0.2 percent lower than SR 520. As was the case for the OGFC-AR, hydrated lime was used as anti-stripping additive. Fibers were added at a rate of 0.3 percent, to help prevent drain-down, as it was on the other two projects.

Mix design for the I-405 Bellevue OGFC-SBS.			
Sieve Size	Gradation	Specifications	Source/Supplier
3/8"	100	100	A-189
#4	38	35-55	A-189
#8	12	9-14	A-189
#200	2.0	0–2.5	A-189
Binder Grade	Percent Asphalt		Source/Supplier
PG70-22	8.6		US Oil, Tacoma, WA
Anti-Strip	Percent		Source/Supplier
Hydrated Lime	1% by wt of aggregate		Graymont Inc.
Fibers	Percent		Source/Supplier
Cellulose Based Paper	0.3		Central Fiber Corporation

Mix Design Comparison for All Three Locations

The two tables below compare the various properties of the mix designs for the OGFC-AR and OGFC-SBS for all three quieter pavement locations. It is intended to show how the similarity of the mix designs for all three projects. The only large difference between the three designs is the use of hydrated lime as the anti-stripping agent on the I-405 Bellevue project.

Comparison of OGFC-AR mix designs for all three locations.				
Property		I-5 Lynnwood	SR 520 Medina	I-405 Bellevue
Gradation	3/8"	100	100	100

	#4	34	31	35
	#8	8	8	8
	#200	1.5	1.6	1.9
Binder Grade		PG64-22	PG64-22	PG64-22
Asphalt Content (%)		9.2	9.0	9.4
Anti-Strip Type		Liquid ARR-MAZ 6500	Liquid ARR-MAZ 6500	Hydrated Lime
Crumb Rubber (%)		22	23.5	20.0

Comparison of OGFC-SBS mix designs for all three locations.

Property		I-5 Lynnwood	SR 520 Medina	I-405 Bellevue
Gradation	3/8"	100	100	100
	#4	37	36	38
	#8	10	12	12
	#200	2.1	2.3	2.0
Binder Grade		PG70-22	PG70-22	PG70-22
Asphalt Content (%)		8.3	8.8	8.6
Anti-Strip Type		ARR-MAZ 6500	ARR-MAZ 6500	Hydrated Lime
Stabilizing Additive (%)		0.30	0.30	0.30

Gradation and Asphalt Content

I-5 Lynnwood

Gradation testing was within specification. Asphalt content testing was not required. The report states that it is not possible to test asphalt content in an asphalt rubber or SBS mix. The Contractor's production records were used to estimate the asphalt content in the tables below.

Gradation, percent asphalt and percent rubber results for I-5 Lynnwood OGFC-AR.

Sieve	Target	Date					Specification
		8/17	8/19	8/19	8/20	8/20	
3/8	100	99	100	100	100	100	100
#4	34	36	33	33	32	36	30-45
#8	8	8	8	7	7	8	4-8
#200	1.5	1.6	1.6	1.6	1.5	1.8	0-2.5
%AC	9.2	9.01	9.64		9.20		9.2

%CRM	22.0	22.0	22.0	22.0	22.0
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Gradation and percent asphalt results for I-5 Lynnwood OGFC-SBS.						
Sieve	Target	Date				Specification
		8/17	8/25	8/26	9/22	
3/8	100	99	100	100	100	100
#4	37	35	37	40	41	35-55
#8	10	8	11	11	12	9-14
#200	2.1	0.8	2.3	2.5	2.0	0-2.5
%AC	8.3	8.2	-	8.3	-	8.3

SR 520 Medina

Gradation tests were within specification. Asphalt content was estimated as we were unable to obtain production records from the contractor.

Gradation and percent asphalt results for SR 520 Medina OGFC-AR.			
Sieve	Target	Average Test Result	Specification
3/8	100	99	100
#4	31	30	30-45
#8	8	7	4-8
#200	1.6	1.6	0-2.5

Gradation and percent asphalt results for SR 520 Medina OGFC-SBS.			
Sieve	Target	Average Test Result	Specification
3/8	100	99	100
#4	36	34	35-55
#8	12	11	9-14
#200	2.3	2.4	0-2.5

I-405 Bellevue

None of the gradation samples were within specifications on the #200 sieve for either the OGFC-AR or the OGFC-SBS. Six of the ten samples were also out of specifications on the #8 sieve for both the AR and SBS samples. Asphalt content was estimated as we were unable to obtain production records from the contractor.

Gradation, percent asphalt and percent rubber results for I-405 Bellevue OGFC-AR.

Sieve	Target	Date					Specification
		8/15	8/15	8/16	8/16	8/16	
3/8	100	100	100	100	100	100	100
#4	35	35	34	37	31	36	30-45
#8	8	10	9	11	8	10	4-8
#200	1.9	3.1	3.3	3.3	3.3	3.1	0-2.5

Note: Values in red are results that are out of specifications.

Gradation, percent asphalt and percent rubber results for I-405 Bellevue OGFC-SBS.

Sieve	Target	Date					Specification
		8/15	8/15	8/16	8/16	8/16	
3/8	100	100	100	100	100	100	100
#4	38	41	38	40	49	40	35-55
#8	12	14	12	16	13	15	9-14
#200	2.0	2.9	3.2	3.2	3.3	3.0	0-2.5

Note: Values in red are results that are out of specifications.